“Prosumage” and the British Electricity Market

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Executive summary

For most of the history of the electricity industry, household customers were pure consumers, but the dramatic growth of roof-mounted PV systems means many have now become producers, or “prosumers”. The rapid fall in the cost of battery storage systems means that some of these households are now engaged in “prosumage”, and their numbers are expected to rise.

The intermittency of renewable output creates many challenges for managing an electricity system, and electricity storage is widely acknowledged as a potential solution. Numerous engineering studies show that distributed energy storage can be centrally coordinated to benefit both the storage owner and the wider system operation, contributing towards energy arbitrage, balancing, and multiple other services. But what if households are disconnected from these other markets, oblivious to real-time price signals, and incentivised to act in a purely self-interested way? Household energy consumption is governed by habit rather than rational profit-optimisation, and consumers are resistant to real-time pricing. Furthermore, while aggregators could in principle provide a route for households to sell complex services without having to deal with complexity, the transactions costs involved could be prohibitive.

We therefore model storage with a deliberately ‘dumb’ approach, operating alongside rather than within the national electricity market to simply maximise households’ self-consumption. We explore the economics of such a storage system for British households in a 2030 scenario, and their impact on the wider system. We used the DESSTinEE model (available open-source from http://wiki.openmod-initiative.org/wiki/DESSTinEE) to model the pattern of future electricity demands, and the Renewables Ninja (available at https://www.renewables.ninja) to model the output from PV panels.

The market and renewable support arrangements in Britain mean that households in London on a standard tariff pay about 14 p/kWh for each unit of power bought from the grid, and are paid 6.64 p/kWh for each unit actually generated by their solar panel, but get no credit for any units actually exported to the grid. Storing a unit that would otherwise be exported and worthless, and converting it into an avoided purchase worth 13 p/kWh (some energy is lost in the process) might seem an attractive opportunity, but we show that battery costs are still far too high to make this economically worthwhile. The profit per kWh of a smaller battery is higher, but so are installation costs.

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Self-interested storage operation is not particularly helpful for national electricity systems. Naïvely charging with all available solar power may leave the store full by midday and unable to flatten the trough in net demand caused by peak solar output. Similarly, discharging only to eliminate electricity purchases does less than it could to ease the evening peak – leaving batteries to discharge overnight when national demand is much lower. Contrast this to the paper by Schill *et al*. in this symposium, whose results show that grid-aware prosumage households with system-oriented charging patterns can reduce total system costs by contributing positively towards these issues.

Self-sufficiency is the most extreme form of prosumage, allowing electricity autarky for individual households. At the moment, many network costs are recovered through per-kWh charges, and grid-connected customers with PV systems pay a relatively small share of these. If network costs were rebalanced towards a fixed charge for every grid-connected household, this could lead to a significant rise in bills for PV owners. While this would give an incentive for completely disconnecting the household, it is neither economically or energetically justifiable. Within mid-latitude European countries, it would require extreme over-engineering. Spanish households would have to over-size their PV panels to meet 150% of annual consumption, and still hold 9 days of electricity storage; whilst British households would require a full month of storage even with twice as many panels as needed (implying 50% of PV output is spilled).

Networked electricity systems developed for a reason: they exploit diversity in demand and in supply, minimising the need for expensive over-building. We have shown that, even with the unexpectedly low-cost Powerwall, and a pricing system that seems designed to encourage it, energy arbitrage cannot make consumer-based storage economic. The economic case for grid-scale storage is based on the wide variety of services that it can provide, but the complexity of the business models involved is a major obstacle to consumer-led deployment of energy storage.

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